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Surface water quality under the Sustainable Development Agenda – the role of improved wastewater treatment

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Inadequately managed wastewater is the key driver of water quality deterioration in various regions across the world, threatening both human livelihoods and ecosystem health. Furthermore, improving wastewater management practices can supplement clean water supplies and promote sustainable development. For these reasons, Sustainable Development Goal (SDG) 6.3 sets the target of halving the proportion of untreated wastewater discharged to the environment by 2030. Yet, the impact of achieving this goal on pollutant concentrations in river waters is largely unknown.

In this work, we use a newly developed high-resolution global surface water quality model (*DynQual*) to estimate the state and future development of water quality variables that are of key social and environmental relevance: water temperature (Tw), salinity (indicated by total dissolved solids, TDS), organic pollution (indicated by biological oxygen demand, BOD) and pathogens (indicated by faecal coliform, FC). We first simulate river water quality for a historical time period (1980 – 2015) as in-stream concentrations of Tw, TDS, BOD and FC at 5 arc-minute spatial resolution (~10km) globally and at the daily timestep, and validate these results against (in-situ) water quality observations from monitoring stations worldwide. In a next-step, we simulate in-stream the same water quality parameters up to 2030 under two scenarios: 1) no expansion in wastewater treatment; and 2) expansions to halve the proportion of untreated wastewater globally by 2030 (i.e., as stipulated by SDG6.3). We compare these scenarios to evaluate the relative impact of halving the proportion of untreated wastewater on global water quality.

We find that in most world regions the irrigation and manufacturing sectors are the major drivers of anthropogenic salinity (TDS) loadings, whereas the largest organic (BOD) and pathogen (FC) pollution loadings originate from the domestic and intensive livestock sectors. Considering also the dilution capacity of the stream network, hotspots of salinity pollution are found in industrialised regions such as northeastern China and the contiguous United States, and in heavily irrigated regions such as northern India. Hotspots of organic and pathogen pollution are closely associated with locations downstream of large urban settlements, and especially those with limited wastewater treatment capacities. Increasing wastewater treatment capacities in line with SDG6.3 leads to substantial decreases in both pollutant loading exports and in-stream

concentrations, substantially reducing the frequency and magnitude of water quality threshold exceedance.

Our work is important for identifying pollutant hotspots and supplementing available observed water quality data, which is extremely sparse in some world regions (e.g. Africa). Our framework also allows for scenario modelling under future projections of climatic and social change, as demonstrated in this work with respect to SDG6.3.